Japan International Cooperation Agency (JICA)
National Geographical Institute (IGN)
National Institute for Seismology, Volcanology, Meteorology and Hydrology (INSIVUMEH)
Secretariat of Planning and Programming for the Presidency (SEGEPLAN)

THE STUDY FOR ESTABLISHMENT OF BASE MAPS AND HAZARD MAPS FOR GIS IN THE REPUBLIC OF GUATEMALA

FINAL REPORT (MAIN REPORT)

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PREFACE

In response to a request from the Government of the Republic of Guatemala, the Government of Japan decided to conduct the Study for Establishment of Base Maps and Hazard Maps for GIS in the Republic of Guatemala and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA dispatched a study team headed by Mr. Kazuo Furukata of Kokusai Kogyo Co., Ltd. to the Republic of Guatemala, six times between December 2000 and November 2003.

The team held discussions with the officials concerned in the Government of the Republic of Guatemala, and conducted field surveys in the study area of 30,000 km^2. Upon returning to Japan, the team prepared this report and completed the GIS database and national base and hazard maps.

I hope that this report will contribute to the promotion of future development projects in the Republic of Guatemala and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials of the Government and those concerned in the Republic of Guatemala for the close cooperation they extended to the study.

November 2003

Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

Mr. Kazuhisa Matsuoka
Vice President
Japan International Cooperation Agency

November 2003

Letter of Transmittal

We are pleased to submit to you the report on the Study for Establishment of Base Maps and Hazard Maps for GIS in the Republic of Guatemala.

This study was conducted by a study team headed by myself, Kazuo Furukata of Kokusai Kogyo Co., Ltd., under a contract to JICA, from December 2000 to November 2003.

The team held discussions with the officials concerned in the Government of the Republic of Guatemala, and conducted field studies that included aerial photography, control point and disaster history surveys, and technology transfers. In Japan, the study team carried out plotting of modifications using the latest digital plotting system, creation of digital orthophoto maps and building of the GIS database, then prepared national base maps on a scale of 1:50,000 covering an area of approx. 30,000km^2 in Guatemala, together with digital data on CD-ROMs and printed maps, and also orthophoto maps on a scale of 1:10,000, hazard maps, digital data on CD-ROMs and printed maps.

This report covers the production process, study results and proposals for the future.

On behalf of the study team, I would like to express our heartfelt gratitude to the officials of the Government of the Republic of Guatemala and of the organizations concerned for their assistance and close cooperation during our stay in Guatemala.

I also wish to express my sincere appreciation for the invaluable advice and cooperation we received from JICA as well as from those concerned in the Ministry of Foreign Affairs and the Ministry of Land, Infrastructure and Transport, and from the Japanese Embassy and JICA office in Guatemala during the period of the survey,

Very truly yours,

Kazuo Furukata
Team Leader
Study Team on Establishment of Base Maps and Hazard Maps for GIS in the Republic of Guatemala

Areas for production of 1:50,000 national base maps

Areas for production of 1:10,000 orthophoto maps

Location Map for the Study for Establishment of Base Maps and Hazard Maps

Photos of the great earthquake in 1976 disaster areas stricken by Hurricane Mitch, and a photo of Pacaya Volcano

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Chapter 1 Study Outline

1.1 Background

The Republic of Guatemala (hereinafter referred to as "Guatemala") forms a part of the Yucatán Peninsula, bordering Mexico, Honduras, El Salvador and Belize, and facing the Caribbean Sea and the Pacific Ocean. It has a population of approximately 11.1 million, the largest in Central America, and an area of 108,889km^2.

Guatemala has been a republic since it gained independence from Spain on September 15, 1821. The civil war that broke out in 1960 expanded nationwide and lasted for 36 years, resulting in the longest suffering in Central America. In the meantime, the economy was exhausted and the residents in the war zone became refugees within and outside the country. Most of the social infrastructure including roads, bridges, waterworks, schools and medical institutions were destroyed.

A "Peace Agreement" which led to the final agreement under global observation was executed on December 29, 1996 with the slogan "the control of law and the respect of human rights" to promise the proliferation of democracy. After the civil war, the Government of Guatemala established the "Working Plan for Performance of the Peace Agreement" as the action plan for economic, political and social aspects and exerted considerable effort to realize the plan. Initially, the peace promotion process made favorable progress, but in 1998, the performance of the Peace Agreement was hindered by domestic political disorder caused by economic problems including taxation reform followed by unprecedented disaster, Hurricane Mitch in November of the same year.

Looking at natural disasters on the other hand, Guatemala is located at the junction of three tectonic plates, the Caribbean Plate, North American Plate and Cocos Plate, and has suffered from great disasters such as earthquakes and volcanic eruptions caused by plate movements. In addition, the geology and sharp terrain have conditions that are apt to cause landslides and floods due to hurricanes. The many types of disaster in Guatemala and the high risk of disaster in the metropolitan city of Guatemala are very striking in Central America.

Considering these circumstances, the Government of Guatemala faces many problems including acquisition of a district for settling refugees in a safe area and re-development of social infrastructure that are indispensable for the Peace Agreement. In the course of land development, Guatemala has given high priority to "disaster prevention" as an urgent program.

For planning the disaster prevention programs, it is an urgent necessity to develop and establish hazard maps. In addition, for making the development plan the national base maps

showing the latest geographic information are necessary. However, most of the national base maps of Guatemala were produced by the U.S.A. in the 1960's, and have not been updated with current conditions.

Therefore, the Government of Guatemala has organized the Inter-ministry Liaison Conference (hereinafter "SNIG") to make effective use of and update the national base maps and promote the common use of information and organizational establishment for practical use of GIS under the policy of "Establishment of Base Maps for GIS". Under this concept, the national base maps covering the northern and central areas have been digitized under the assistance of the U.S.A and France, but those areas are only a part of the entire country.

Considering the background as described above, the Government of Guatemala made a request to Japan for cooperation in development of "the national base mapping system for the southern, middle and western areas" in 1998. After that, Guatemala suffered from the disaster of Hurricane Mitch in October of 1998 and JICA implemented the "Study of Formulation of the Hurricane Reconstruction and Disaster Prevention Project" for the period of November to December 1999. As the result of the study, JICA dispatched the preparatory study team in June 2000 and the preliminary study team in August 2000. Then, the S/W was concluded between JICA Study Team and the IGN and INSIVUMEH of Guatemala as the implementing agencies.

1.2 Objectives of the Study

The objectives of the study are to modify the existing national base maps (1:50,000 scale covering the area of approx. 30,000 km^2) according to temporal changes and digitize them in order to provide data for GIS. Also, to produce hazard maps (1:20,000 to 1:50,000 scale covering the area of approx. 10,000 km^2) for earthquakes, volcanoes, landslides, and flooded sites to use for disaster prevention.

1.2.1 Establishment of GIS base map data

- Digitization of 1:50,000 topographic maps
- Modification of changes in 1:50,000 topographic maps (production of films for printed maps)

1.2.2 Production of hazard maps

- Production of 1:10,000 orthophoto maps
- Survey of disaster history and others
- Production of hazard maps

1.2.3 Technology transfer

In this study, technology transfer will be carried out through on-the-job-training and joint work: the technology of digitizing base maps, modification of temporal changes, creation of map files for printing and production of orthophoto maps, national base maps and GIS database production and application using database to IGN; production of hazard maps, simulation method and work related to INSIVUMEH.

In addition, seminars and workshops were held for the SNIG member agencies and organizations including IGN and INSIVUMEH. These covered applied use of GIS, such as classifying the development plans and disaster prevention programs, and the database maintenance techniques from a comprehensive point of view as well as individual point of view unique to each agency.

In the technology transfer, newly procured study equipment and materials were used and the most up-to-date technology was introduced.

1.3 Study Areas

1.3.1 Study area for establishment of GIS base maps

The study areas will be approximately 30,000 km^2 in the southwestern area of Guatemala (covered by 74 sheets of existing topographic maps). For the detailed location, refer to the location map in this report.

1.3.2 Study area for production of hazard maps

(1) Earthquakes (Approx. 600 km^2)

1:20,000 scale: Guatemala City, Quetzaltenango, Mazatenango, Escuintla, and Puerto Barrios

1:50,000 scale: Guatemala City

(2) Volcanoes (approx. 1,700 km^2)

1: 25,000 scale: Santiaguito, Cerro Quemada and Pacaya volcanoes

1:50,000 scale: Tacana volcano

(3) Landslides

1: 25,000 scale (approx. 1,400 km^2): Guatemala City, Quetzaltenango and Antigua

1:50,000 scale slope classification map (approx. 5,000 km^2): Northwest region (El Quiche, Huehuetenango, San Marcos) and Central region (Sacatepequez, Chimaltenango, Solola)

(4) Floods (1: 25,000 scale: 2,000 km^2)

Samala basin, Acome basin, Achiguate basin and Maria Linda basin

1.4 Scope of the Study

This study was conducted for 4 fiscal years, and the work per year is listed in Table 1.4-1.

Table 1.4-1 Study work

Year	Work Division	Work
First Year	Preparatory work in Japan	Collection of information and materials Preparation of Inception Report
	First field survey	Explanation/discussions of Inception Report Aerial photography: 1:40,000 & 1:20,000 Discussions about GIS/printed map specifications, OJT scope and investigation of existing conditions Rasterizing of existing topographic maps Discussions about orthophoto mapping plan, OJT scope and investigation of existing conditions Control point survey and pricking Discussions about hazard map production plan and investigation of existing conditions
	First work in Japan	Preparation of Progress Report 1
Second Year	Second field survey	Explanation/discussions of Progress Report 1 Photo interpretation/temporal change detection Investigation of administrative boundaries/names and terrain/planimetric features Preliminary interpretation of landform classification, disaster history and river flood Natural/social environment hazard map field survey Discussions about seminar details
	Second work in Japan	Vectorization of basic spatial information database Digital plotting of modifications Merge modified plotted data with existing data Creation of DEM Aerial photo negative film scanning Automatic aerial triangulation Creation of DEMs and contour lines Digital plotting of topographic data, and horizontal and vertical sectioning of rivers Production of orthophotos Preliminary photo interpretation for landform classification Production of geomorphological maps/slope classification maps Organization of social disaster factors 1 Preparation of Progress Report 2
Third Year	Third field survey	Explanation/discussions of Progress Report 2 Transfer of technology for vectorization, plotting of modifications and DEM creation Investigation of public buildings, and administrative boundaries/names Transfer of technology for aerial triangulation, DEMs and contouring Discussions about simulation method and field completion of geomorphological maps Transfer of technology for hazard map production

Year	Work Division	Work
	Third work in Japan	Digital compilation of basic spatial information database Digital compilation of printed map data Digital compilation/structuralizing Production of output maps and CD-ROMs Arrangement of social disaster factors 2 Digitization of various thematic maps Disaster forecast simulation and analysis of earthquakes, volcanic product flows and river floods Production of hazard maps Examination of hazard map application methods and disaster prevention reinforcement
	Fourth field survey	Transfer of technology for structuralization and GIS application Field completion of basic spatial information database Transfer of technology for topographic mapping and orthophoto creation Transfer of technology of map symbolization and digital compilation
	Fourth work in Japan	Structuralizing of GIS database Supplementary digital compilation of map data for printing Preparation of Progress Report 3
Fourth Year	Fifth field survey	Explanation/discussions of Progress Report 3 Transfer of technology for structuralization and GIS application Transfer of technology for topographic mapping for temporal changes Transfer of technology for map symbolization and digital compilation GIS and Hazard map seminar Recommendations and discussions for disaster prevention measures
	Fifth work in Japan	Positive film output for reproduction, production of CD-ROMs Production of various types of digital data and output maps Preparation of Draft Final Report
	Sixth field survey	Explanation/discussions of Draft Final Report Technology transfer workshop
	Sixth work in Japan	Preparation of Final Report and final products

1.5 Basic Policies

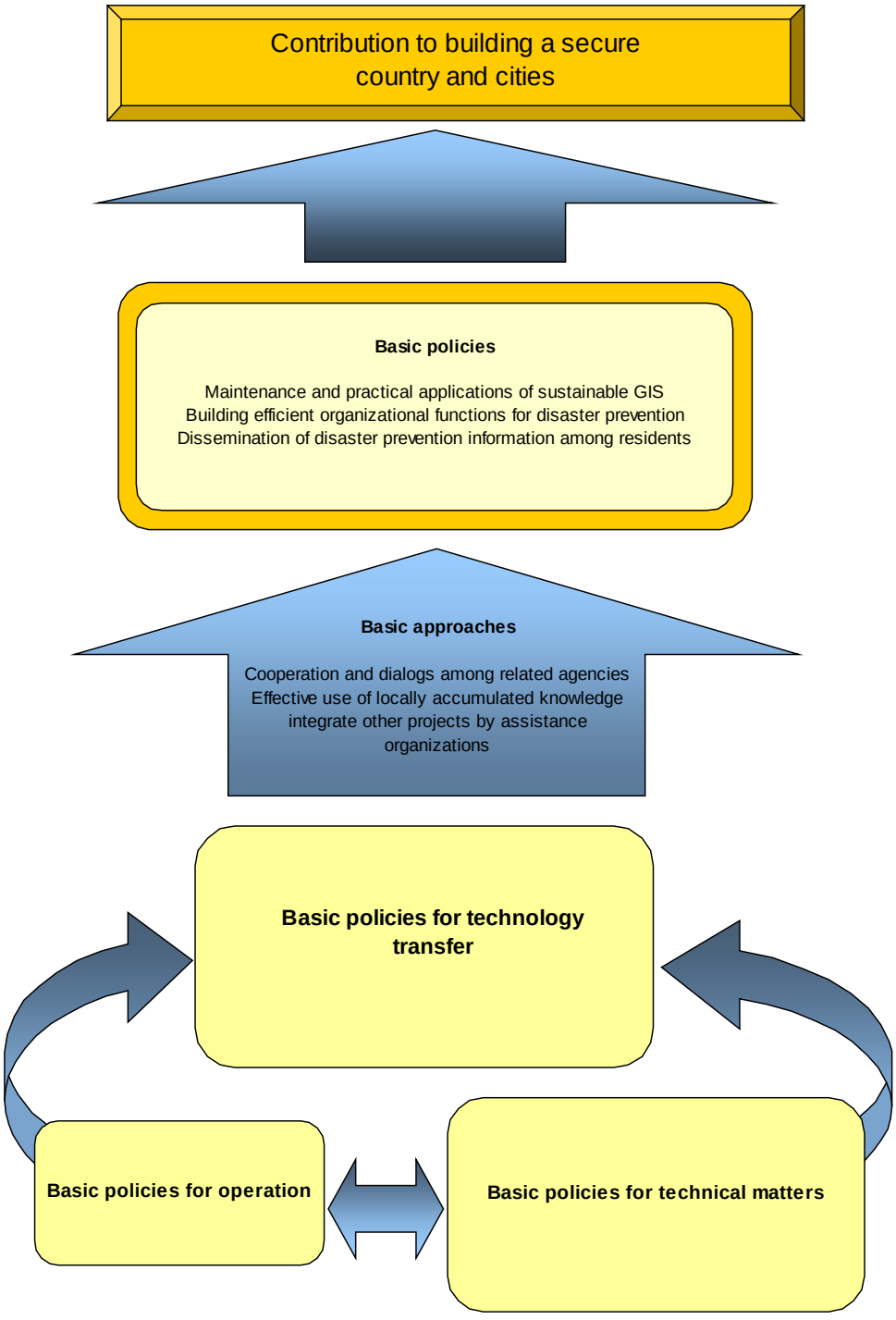

Figure 1.5-1 Conceptual overview of basic policies

1.5.1 Basic policies for operation

(1) Establishment of optimum communications system and discussions

For the development of GIS base maps and various hazard maps the study team will require an exchange of information not only with the counterpart agencies IGN and INSIVUMEH but also with SNIG and other governmental agencies of Guatemala. In addition, the study team will have close cooperation and mutual discussions with the related agencies of Guatemala to promote the effective use of GIS and practical disaster prevention measures.

For effective implementation of the study tasks and technology transfer, an optimum implementation organization and a mutual liaison organization will be organized with the members from both Guatemala and Japan.

In addition to both organizations, two study team offices to be provided for the field survey will be set up in order to conduct surveys simultaneously. Although the survey results are different, most of the data will be shared, and it is essential to make close liaison and exchange of information among the study team members as well as among the counterpart agencies and between both sides.

(2) Thorough safety measures

① The study team will have discussions with the counterpart agencies and other agencies about all areas of the study and obtain security information for these areas.

② The study team will give relevant notice to the public office in each corresponding area prior to start of the field survey and take safety measures by employing local guides and guards who are very familiar with the local conditions to accompany the study team members.

③ As it is foreseen that arms will be used in many crimes, all the members of the study team and the counterparts will be instructed to make no unnecessary resistance to any criminal act and to give the highest priority to the safety of life by following the orders of the criminals.

④ The study team members will carry satellite phones with them for communications and basic safety.

⑤ The occurrence of any trouble will promptly be reported to the relevant Guatemalan agencies and the Japanese embassy in Guatemala as well as the JICA office to take appropriate measures.

1.5.2 Basic policies for technical matters

IGN and INSIVUMEH are responsible for different services, however, both agencies recognize that the GIS base map database and hazard maps are most important for national land conservation.

In addition, all of the governmental agencies, universities and institutes including SEGEPLAN (Secretariat of Planning and Programming for the Presidency), CONRED (National Committee of Disaster Prevention) and MAGA (Ministry of Agriculture, Stockbreeding and Food) are expecting the products from this study and technology transfer of production. Considering these circumstances, the study team has formulated the basic policies for technical matters as described below.

[GIS]

(1) Establishment of technical specifications

The study team will establish technical specifications that will be the basis for future expansion and improvements of data production and strengthening technical capability.

(2) Thorough quality control and process management for building database

The main products that the study team will produce in this study are as follows:

- ♦ GIS database
- ♦ Data for map printing (printing film)
- ♦ Digital orthophoto maps
- ♦ Hazard maps

The quality control of digital data will mainly be divided into logic tests of the data and visual tests of output maps, and these tests will be carried out for each process.

Data is also different between CAD software for data acquisition and editing and the GIS software to use the data, so that the quality control of digital data will be thorough and complete.

On the other hand, both orthophoto data and GIS base map data will be used as background data for hazard maps, so that it will be very important to have good coordination between the work in Guatemala and in Japan. Not only the study team members but also the personnel engaged in plotting and simulation work in Japan have to be aware of the progress at all times and carry out the work according to the work/progress schedule.

[Hazard maps]

(3) Building database of basic information for disaster prevention

INSIVUMEH and CONRED are the agencies associated with disaster prevention information. The study team will define the role of each agency and cooperate with them to ensure that the basic information for disaster prevention will be organized and shared by both agencies.

(4) Production of geomorphological maps for production of hazard maps

As topographic changes occur due to various phenomena and conditions, the geomorphological maps are very important materials for disaster prediction. However, Guatemala has no geomorphological map produced by any governmental agency, except 1:250,000 scale maps produced by MAGA. The study team considers it important to produce hazard maps for comparing the past disasters with the geomorphological maps. Therefore, geomorphological maps will be produced to show the relations between the topography and disasters in Guatemala.

(5) Simulation of main disaster factors

To carry out the simulation of disaster factors, information such as seismic and meteorological data has to be collected from INSIVUMEH and other relevant agencies. The study team will input these disaster factors to the simulation program developed in Japan and forecast the strength and frequencies of each factor to cause a disaster as well as the extent of the area affected by the disaster.

1.5.3 Basic policies for technology transfer

The study team will provide technology transfer through OJT, seminars and workshops during the study period of 36 months to the counterparts to give training and exposure to the practical use of the products of the study and a wide-range of technology.

Technology transfer has to be provided not only to the counterparts in charge of this study but also to other engineers of relevant agencies. Therefore, the study team will prepare manuals to facilitate broad understanding and technology transfer.

[GIS]

(1) Database creation methods and GIS applications

- **1:50,000 vectorizing, modification plotting and DEM creation**

  Most of map elements used in existing topographic maps have to be digitized

(vectorized) to produce digital data for printed maps. The study team will provide technology transfer in each process of plotting modifications of temporal changes to the database and the DEM creation with completed contour lines. They will use the study equipment including editing and digital plotting equipment and the newly created data.

・1:50,000 symbolization and digital compilation

The database described above is a collection of single points (houses, etc.), lines (roads, rivers, etc.) and polygons (cultivated lands, etc.), which will be compiled and symbolized (represented as compound lines for roads and rivers) in accordance with specifications for printing data.

The study team will also provide technology transfer with regard to this work through OJT using compilation software for the study equipment.

・Structuralization and GIS application

To make the GIS database from the above database, the spatial information divided into map sheets should be joined and the attribute information should be added to the basic features. To configure a network (such as a road or river), the connecting information (logical continuity) should be acquired within the scope of the study. For polygons (closed figures), the features that extend over neat lines should be joined.

The hazard maps produced using this database will be available from the GIS, but for application of the hazard maps, more databases such as thematic maps and social infrastructure data will be required. For this purpose, the attribute database should also be created. Considering these points, the study team will provide technology transfer for the effective application of GIS.

(2) Production, maintenance and management of orthophoto maps

・Aerial triangulation, DEM and contour line creation

The study team will improve the technical capability and map maintainability of IGN using the digital plotter, provided by the study.

The plotter will be loaded with many software programs and functions to execute a wide range of jobs from aerial triangulation to the final topographic mapping data compilation. Therefore, technology transfer will be conducted in two stages.

In the first stage, aerial triangulation as the base for all work and analytical calculations from the observation of photo coordinates will be carried out to calculate all of the orientation elements in aerial photos.

Then, the calculated data will be used to create DEMs (Digital Elevation Models) and TINs (Triangulated Irregular Networks), which will be used to produce contour lines. The processes up to the calculations will be transferred.

- **Topographic plotting and orthophoto creation**

In the second stage of technology transfer, the technologies of orthophoto creation and mosaic technique as well as the methods of measuring and drawing planimetric features necessary for topographic map representation will be transferred. At the same time, the technology of plotting modifications of temporal changes on 1:50,000 topographic maps will also be transferred.

[Hazard maps]

(3) Field survey for landform classification and photo interpretation

The geomorphologic maps will be created through photo interpretation and field survey. The geomorphologic data will be created by alternately conducting photo interpretation and field identification and with more detail if the observation points are more frequent. The study team will transfer the technology of field survey and photo interpretation through OJT, focusing on topography and disasters (hazards). In addition, the study team will emphasize the importance and effectiveness of geomorphologic maps to a broad range of academic professionals through technology transfer.

(4) Basic idea of simulation of main disaster factors

The simulations to be implemented in the Study and the extent of the hazard maps to be created are limited to a portion of Guatemala. The study team will provide technology transfer with regard to the basic idea, algorithms and output images to ensure the engineers will understand them better and can create hazard maps in the future. The simulation technology will also be explained to the professionals at San Carlos University.

(5) Use of hazard maps

As described previously, the start of disaster prevention is to create hazard maps. In the event of the eruption of Nevado del Luis volcano in Colombia, the hazard maps were not disclosed even though they had been produced, resulting in 25,000 victims. How to use hazard maps depends upon the administrative ability. The study team will transfer the technology of the method for using hazard maps in Guatemala by referring to cases of using hazard maps in

1.6 Contents of the Study

1.6.1 Contents of the Study

(1) Items, outline and volume of work

The items, outline and volume of work in the Study are classified by fiscal year, and will be implemented as shown in Table 1.6-1 Planned Work. The detailed work schedule is shown in Table 1.6-3.

(2) Overall flow of work

For better understanding of the background, objectives and details of this study, a work flow chart covering the study work is shown in Figure 1.6-1, as discussed in Section 1.5 Basic Policies.

Table 1.6-1 Planned work

Year	Division	No.	Work	Work outline	Work volume
First Year	Japan	Owp-1	Collection of information and materials	Collection and analysis of materials for this study	—
		Owp-2	Preparation of Inception Report	Basic policies, methods, processes and procedures of the study	English 30 copies, Spanish 25 copies
	Guatemala	Fw1-1	Explanation/discussions of Inception Report	Explanation, discussions, confirmation and agreement with Guatemala counterparts	—
		Fw1-2	Aerial photography: 1:40,000 & 1:20,000	1:40,000 & 1:20,000-scale photography (monochrome)	Approx. 24,600km^2（1: 40,000） Approx. 7,000km^2（1: 20,000）
		Fw1-3	Discussions on GIS/printed map specifications, about OJT scope and investigation of existing conditions	Discussions about GIS data structure and printed map digitizing specifications, and collection and investigation of materials	
		Fw1-4	Rasterizing of existing topographic maps	Digitizing with scanner (IGN's technical cooperation)	5 versions x 74 sheets = approx. 370 sheets
		Fw1-5	Discussions about orthophoto mapping plan, OJT scope and investigation of existing conditions	Confirmation of survey standards with the counterparts of Guatemala and collection and investigation of materials	
		Fw1-6	Control point survey and pricking	GPS survey (IGN technical cooperation)	Control points: 20 Prick points: Approx. 175 GPS bench marks: 25
		Fw1-7	Discussions about hazard map production plan and investigation of existing conditions	Understanding of hazard maps, existing data and potential needs	Earthquakes: Approx. 600 km^2 Volcano: Approx.1,700km^2 Landslide: Approx. 1,400km^2 (Slope classification map: approx. 1,400km^2) Floods: 2,000 km^2
	Japan	PR/R-1	Preparation of Progress Report 1	The details of the first-year work will be compiled.	English: 20 copies Spanish: 20 copies

Year	Division	No.	Work	Work outline	Work volume
Second Year	Guatemala	Fw2-1	Explanation/discussions of Progress Report 1	The results of the first-year work will be explained for approval.	Same as above
		Fw2-2	Photo interpretation/temporal change detection	Extraction of temporal changes from new aerial photos	
		Fw2-3	Investigation of administrative boundaries/names and terrain/planimetric features	Field survey of terrain and planimetric features (IGN technical cooperation)	Areas with temporal changes
		Fw2-4	Preliminary interpretation of landform classification, disaster history and river flood	Detailed interpretation of aerial photos	
		Fw2-5	Natural/social environment study hazard map field survey	Check and analysis of disaster factors from natural and social viewpoints	
		Fw2-6	Discussions about seminar details	Discussions and confirmation of seminars	
	Japan	Ow2-1	Vectorizing of basic spatial information database	Creating GIS/Printing basic data	
		Ow2-2	Digital plotting of modifications	Plotting of temporal changes	
		Ow2-3	Merge of modified plotted data with existing data	Merging of spatial base map database and temporal changes	
		Ow2-4	Creation of DEM	Mesh intervals 40m, contour line intervals 5m	
		Ow2-5	Aerial photo negative film scanning	Negatives of aerial photos will be converted to image data.	Approx. 1,569 sheets
		Ow2-6	Automatic aerial triangulation	Aerial triangulation by batch processing	Approx. 1,500 models
		Ow2-7	Creation of DEMs and contour lines	Automatic generation of DEMs followed by creation of contour lines using TIN	
		Ow2-8	Digital plotting of topographic data, and longitudinal survey and cross sectional survey using aerial photos	Plotting of roads, rivers and annotations, horizontal and vertical sections approx. 500m wide at 2km pitch	Plotting: Approx. 7,000km^2 Horizontal/vertical section: 50km at pitch of 2km
		Ow2-9	Production of orthophotos	1:10,000 to be stored in map sheet units	
		Ow2-10	Preliminary photo interpretation for landform classification	Understand the relation between landform classification, rough geological distribution and risk of disaster	
		Ow2-11	Production of geomorphological maps/slope classification maps	To be produced based on national base maps and orthophotos	
		Ow2-12	Arrangement of social disaster factors 1	Collection and arrangement of data of social vulnerability in disaster occurrence	
		PR/R-2	Preparation of Progress Report 2	The details of the second-year work will be compiled.	English : 20 copies, Spanish : 20 copies
Third Year	Guatemala	Fw3-1	Explanation/discussions of Progress Report 2	The results of the second-year work will be explained for approval.	As above
		Fw3-2	Transfer of technology for vectorizing, plotting of modifications and DEM creation	Technology transfer will be carried out using manuals and study equipment.	
		Fw3-3	Investigation of public buildings, and administrative boundaries/names	Field survey and information collection will be carried out (IGN technical cooperation).	

Year	Division	No.	Work	Work outline	Work volume
Third Year	Guatemala	Fw3-4	Transfer of technology for aerial triangulation, DEMs and contouring	Technology transfer will be carried out using manuals and study equipment.	
		Fw3-5	Discussions about simulation method and field completion of geomorphological maps	Discussion about simulation methods, interim progress report	
		Fw3-6	Transfer of technology for hazard map production	Description of countries advanced in hazard map production, promotion of understanding of disaster risks	
Third Year	Japan	Ow3-1	Digital compilation of basic spatial information database	Digital compilation, using specifications for GIS data and printed maps	
		Ow3-2	Digital compilation of printed map data	Compilation of topographic maps in according to the specifications for printed maps	
		Ow3-3	Digital compilation/structuralization	Compilation of terrain data, planimetric data, annotations, administrative boundaries	
		Ow3-4	Production of output maps and CD-ROMs	Production of output maps by printer, data storage on CD-ROMs	
		Ow3-5	Arrangement of social disaster factors 2	Collection and organization of data of social vulnerability in disaster occurrence	
		Ow3-6	Digitization of various thematic maps	Digitizing of each thematic map acquired	
		Ow3-7	Disaster forecast simulation and analysis of earthquakes, volcanic product flows and river floods	Evaluation of hazards	
		Ow3-8	Production of hazard maps	Production of hazard maps based on the results of simulation	
		Ow3-9	Examination of hazard map application methods and disaster prevention reinforcement	Examination of hazard map application	
	Guatemala	Fw4-1	Transfer of technology for structuralization and GIS application	Technology transfer will be carried out using manuals and study equipment.	
		Fw4-2	Field completion of basic spatial information database	Check of data, confirmation of problems in Guatemala	
		Fw4-3	Transfer of technology for map symbolization and digital compilation		
		Fw4-4	Transfer of technology for topographic mapping and orthophoto creation	Technology transfer will be carried out using manuals and study equipment.	
	Japan	Ow4-1	Structuralization of GIS database	Phase structuralization of spatial base map data, coordination with external database	
		Ow4-2	Supplementary digital compilation of map data for printing	On-site supplementary data will be reflected in data for printed maps.	
		PR/R-3	Preparation of Progress Report 3	The details of the third-year work will be compiled.	English: 20 copies, Spanish: 20 copies

Year	Division	No.	Work	Work outline	Work volume
Fourth Year	Guatemala	Fw5-1	Explanation/discussions of Progress Report 3	The results of the third-year works will be explained for approval.	As above
		Fw5-2	Transfer of technology for GIS application	Technology transfer will be carried out using manuals and study equipment.	
		Fw5-3	Transfer of technology for map symbolization and digital compilation	Technology transfer will be carried out using manuals and study equipment	
		Fw5-4	Transfer of technology for topographic mapping of temporal changes	Technology transfer will be carried out using manuals and study equipment	
		Fw5-5	GIS and hazard map seminar	Report of disaster factor analysis and recommendations for GIS management policies	
		Fw5-6	Recommendations and discussions about disaster prevention measures	Discussions about disaster prevention measures using hazard maps	
	Japan	Ow5-1	Positive film output for reproduction, production of CD-ROMs_1	Preparation of completed 1:50,000 national base maps	［Digital data］
		Ow5-2	Production of various types of digital data and output maps_1	Preparation of completed hazard maps	
		DF/R	Preparation of Draft Final Report	All the work processes and recommendations for this study will be compiled.	English : 20 copies Spanish : 20 copies Summary English: 20 copies Spanish : 20 copies
	Guatemala	Fw6-1	Explanation/discussions of Draft Final Report	All the work processes and recommendations for this study will be explained for approval.	As above
		Fw6-2	Technology transfer workshop	The technology transfer carried out in this study will be compiled and a workshop and presentation seminar will be held.	
	Japan	Ow6-1	Positive film output for reproduction, production of CD-ROMs_2		Topographic maps/GIS: 20 sets Orthophoto maps: 20 sets
		Ow6-2	Production of various types of digital data and output maps_2		Geomorphological maps: 20 sets Hazard maps: 20 sets Hurricane Mitch disaster survey maps: 20 sets ［Output maps］ Same as above: 10 sets
		F/R	Preparation of Final Report and final products	Completion of the Final Report with comments of the Guatemala counterparts	Hazard maps 100sets English : 20 copies Spanish : 20 copies Summary English: 20 copies Spanish : 20 copies

(3) Members

The Study Team consisted of the following 15 members:

Table 1.6-2 Study team

Role	Name
Team leader	Kazuo FURUKATA
Sub-leader/Data structuralization design/control point survey/field survey supervision	Satoru NISHIO
GIS/structuralization supervision	Daisaku KIYOTA
Photography supervision/field survey supervision	Michiyasu MURATA→Shozo SHIMODA
Control point survey/field survey supervision 1	Morten STRAND
Control point survey/field survey supervision 2	Mutsumi HANADA
Digital compilation supervision	Noboru FUKUSHIMA
Symbolizing supervision	Yumiko SASAKI→Takashi YOSHII→Yoshimitsu FUKUMOTO
Digitization supervision	Chiyo KIGASAWA
Sub-leader/disaster prevention plan	Satoru TSUKAMOTO
Volcanic disaster survey	Hitoshi TAKEUCHI
Flood disaster survey	Hiroyoshi ISHIKAWA
Landslide disaster survey	Valerio GUTIERREZ
Earthquake disaster survey	James WILKINSON→Toshiyuki MATSUMOTO
Coordination	Hiroyuki NAKAI

1.6.2 Items produced

(1) Study reports

1) Inception Report: 20 English and 20 Spanish copies
2) Progress Report 1: 20 English and 20 Spanish copies
3) Progress Report 2: 20 English and 20 Spanish copies
4) Progress Report 3: 20 English and 20 Spanish copies
5) Draft Final Report
   - Main Report: 20 English and 20 Spanish copies
   - Summary: 20 English and 20 Spanish copies
6) Final Report
   - Main Report: 20 English and 20 Spanish copies
   - Summary: 20 English and 20 Spanish copies

(2) Items produced

1) Aerial Photographs (Black and White 1:40,000 and 1:20,000)
   - Negative film of aerial photographs 1 set
   - Diapositive film of aerial photographs 1 set
   - Contact prints of aerial photographs 1 set
   - Photo index map 1 set
2) Results of field survey 1 set
3) Results of aerial triangulation 1 set
4) Printing films for 1:50,000 scale topographic maps 1 set
5) Digital data files (e.g. CD-ROM)
   - 1:50,000 scale topographic maps and GIS base maps 20 sets
   - Hurricane Mitch disaster maps 20 sets
   - Geomorphological maps 20 sets
   - Hazard maps 20 sets
   - Orthophoto maps 20 sets
6) Print out of maps
   - 1:50,000 scale topographic maps 10 sets
   - Geomorphological maps 10 sets
   - Hazard maps 100 sets
   - Hurricane Mitch disaster maps 10 sets

Work Plan

Work Schedule (Project Outline)

Table 1.6-3

Type of Work	Work Item		Study Period (FY 2000 / 2001 / 2002 / 2003)
	Work Division (Field survey/Work in Japan)		Preparatory work in Japan; First work in Japan; First work in Guatemala; Second field survey; Secpnd work in Japan; Third work in Japan; Third field survey; Fourth work in Japan; Fourth field survey; Fifth work in Japan; Fifth field survey; Sixth work in Japan; Sixth field survey
	Submission of Report		IC/R; PR/R1; PR/R2; PR/R3; SEMINA; DF/R; F/R
Common Items	Preparatory work in Japan	Owp-1	Collection of information and materials
		Owp-2	Preparation of Inception Report
	Explanation/discussions of Inception Report	Fw1-1	Explanation/discussions of Inception Report and collection of related materials
	Preparation of GIS base maps	Fw1-2	Aerial photography: 1/40,000 & 1/20,000 (local sub-contract)
	Preparation of reports	PR/R-1	Preparation of Progress Report 1
		PR/R-2	Preparation of Progress Report 2
		PR/R-3	Preparation of Progress Report 3
		DF/R	Preparation of Draft Final Report
	Explanation/discussions of reports	Fw2-1	Explanation/discussions of Progress Report 1
		Fw3-1	Explanation/discussions of Progress Report 2
		Fw5-1	Explanation/discussions of Progress Report 3
		Fw6-1	Explanation/discussions of Draft Final Report
	Technology transfer	Fw6-2	Technology transfer workshop
	Preparation of Final Report and final products	F/R	Preparation of Final Report and final products
1: 50,000 national base maps	Rasterization of national base maps	Fw1-3	Discussions about GIS/printed map specifications and a OJT scope and investigation of existing conditions
		Fw1-4	Rastering of existing topographic maps (IGN's technical cooperation)
	Photo interpretation/vectorization	Ow2-1	Vectorization of basic spatial information database
		Fw2-2	Photo interpretation/temporal change detection
		Fw2-3	Investigation into administrative boundaries/names and terrain/planimetric features (IGN's technical cooperation)
	GIS Database Building	Ow2-2	Digital plotting of modifications
		Ow2-3	Merge of modified plotted data with existing data
		Ow2-4	Creation of DEMs
		Ow3-1	Digital compilation of basic spatial information database
		Fw3-2	Transfer of technology for vectorizing, plotting of modifications and DEM creation
		Fw4-1／Fw5-2	Transfer of technology for stracuralizaion and GIS application
		Ow4-1	Structuralization of GIS database
	Data creation for printing	Ow3-2	Digital compilation of map data for printing
		Fw4-2	Field completion of basic spatial information database
		Ow4-2	Supplementary digital compilation of map data for printing
		Fw4-3／Fw5-3	Transfer of technology for map symbolization and digital compilation
		Ow5-1	Positive film output for reproduction, production of CD-ROMs
Production of orthophoto maps	Plotting of orthophoto maps	Fw1-5	Discussions about orthophoto mapping plan and OJT scope and investigation into actual conditions
		Fw1-6	Control point survey and pricking (IGN's technical cooperation)
		Ow2-5	Aerial photos' negative film scanning
		Ow2-6	Automatic aerial triangulation
		Ow2-7	Creation of DEMs and contour lines
		Ow2-8	Digital plotting of topographic data, and horizontal and vertical sectioning of rivers
		Ow2-9	Production of orthophotos
		Fw3-3	Investigation into public buildings, and administrative boundaries/names (IGN's technical cooperation)
		Fw3-4	Transfer of technology for aerial triangulation, DEMs and contouring
		Ow3-3	Digital compilation/structuralization
		Fw4-4／Fw5-4	Transfer of technology for topographic mapping and orthophoto creation
		Ow3-4	Production of output maps and CD-ROMs
Hazard maps	Basic disaster assessment	Fw1-7	Discussions about hazard map production plan and investigation of existing conditions
		Fw2-4	Preliminary interpretation for landform classification, disaster history study and river flood case study
		Fw2-5	Natural/social environment study hazard map field survey
		Fw2-6	Discussions about hazard map seminar details
	Disaster analysis	Ow2-10	Preliminary photo interpretation for landform classification
		Ow2-11	Production of geomorphological maps/slope classification maps
		Ow2-12／Ow3-5	Arrangement of social disaster factors
		Ow3-6	Digitization of various thematic maps
	Production of hazard maps	Fw3-5	Discussions about simulation method and field completion of geomorphological maps
		Fw3-6	Transfer of technology for hazard map production
		Ow3-7	Disaster forecast simulation and analysis of earthquakes, volcanic product flows and river floods
		Ow3-8	Production of hazard maps
		Ow3-9	Discussion about hazard map application methods and disaster prevention reinforcement
	Discussions about disaster prevention measures	Fw5-5	GIS & Hazard map seminar
		Fw5-6	Recommendations and discussions about disaster prevention measures
		Ow5-2	Production of various types of digital data and output maps
Personnel Plan	Team leader		Kazuo FURUKATA
	Data structuralization design /control point survey/field survey supervision		Satoru NISHIO
	GIS/structuralization supervision		Daisaku KIYOTA
	Photography supervision/field survey supervision		Shozo SHIMODA
	Control point survey/field survey supervision 1		Morten STRAND
	Control point survey/field survey supervision 2		Mutsumi HANADA
	Digital compilation supervision		Noboru FUKUSHIMA
	Symbolizing supervision		Yumiko SASAKI
	Digitization supervision		Chiyo KIGASAWA
	Sub-leader/disaster prevention plan		Satoru TSUKAMOTO
	Volcanic disaster survey		Hitoshi TAKEUCHI
	Flood disaster survey		Hiroyoshi ISHIKAWA
	Landslide disaster survey		Valerio GUTIERREZ
	Earthquake disaster survey		Toshiyuki MATSUMOTO
	Coordination		Hiroyuki NAKAI
	Interpreter 1		Midori OISHI

Legends: Field Survey; Work in Japan; Report submission; Assigned in Japan

Flowchart

Figure 1.6-1